IN THE SPECIFICATION:

Please amend the first full paragraph appearing on page 2 as follows:

This application is a divisional of U.S. Patent Application Serial No. 09/387,640, filed on August 31, 1999, now U.S. Patent No. 6424,033 B1, issued July 23, 2002, which is incorporated herein by reference.

Please amend the third full paragraph appearing on page 2 as follows:

Miniaturization is the process of crowding an increasing number of microelectronic circuits onto a single chip. Additionally, miniaturization involves the reduction of the overall chip package size so as to achieve smaller and more compact devices such as hand-held computers, personal data assistants (PDA), portable telecommunication devices, and the like. Ideally, the chip package size would be no larger than the chip itself. Miniaturization has the counter-productive effect upon chip packaging of an increased heat load upon a smaller chip package. Heat management ~~is therefore~~ is, therefore, an important aspect of producing a reliable microelectronic device. A heat sink for a chip package allows for enhanced performance of the microelectronics.

Please amend the first full paragraph appearing on page 3 as follows:

What is needed in the art is a means of transferring heat away from a ~~micro-electronic~~ microelectronic device that overcomes the heat management problems of the prior art.

Please amend the first full paragraph appearing on page 4 as follows:

The present invention relates to an integrated circuit chip package having an IC chip with an active surface, where the active surface has extending therefrom an electrical connector in electrical communication with the IC chip. The IC chip is mounted upon a substrate such as a printed circuit board (PCB). A grease is in contact with the active surface of the IC chip and a container is disposed upon the substrate. The grease is enclosed within the container and the substrate.

Please amend the third full paragraph appearing on page 4 as follows:

In one embodiment of the present invention, an IC chip is configured as a ~~board-on-chip~~ board-on-chip (BOC) package and a thermal grease is disposed upon the exposed active surface of the ~~chip~~ chip, as well as over the electrical connectors such as bond wires or solder balls if present. A protective shell covers the thermal grease to prevent disturbance of the grease during both assembly thereof and during field use. Alternatively, a dam structure may be disposed upon the board and the protective shell to hold the protective shell in place. Additionally, at least one vent hole may be disposed in the protective shell to allow for thermal expansion and contraction of the grease. The BOC configuration lends itself to a stacked BOC package where multiple occurrences of BOC may be enclosed within a single protective shell.

Please amend the paragraph pages 4 and 5 as follows:

In another embodiment of the present invention, a ~~chip on board~~ chip-on-board (COB) chip package is configured with the grease disposed upon the active surface of the IC chip where the grease also covers the bond wires. The protective shell is disposed upon the grease and is secured against the substrate on the same surface onto which the IC chip is disposed. In a variation of this embodiment, the protective shell is configured to make direct contact with the active surface of the IC chip.

Please amend the second full paragraph appearing on page 5 as follows:

Another embodiment of the present invention comprises a ~~flip chip~~ flip-chip configuration wherein the grease is disposed both upon the active surface of the ~~flip chip~~ flip-chip and upon the balls of a ~~flip chip~~ flip-chip ball array that provides electrical connections to the ~~flip chip.~~ flip-chip. A dam structure may be disposed upon both the ~~flip chip~~ flip-chip substrate and the ~~flip chip~~ flip-chip itself to assist in containing the grease. In a variation of the foregoing involving a ~~flip chip~~ flip-chip upon a flexible substrate, a protective shell is disposed upon the flex substrate and grease substantially encompasses the entire ~~flip chip~~ flip-chip as well

as the ~~flip chip~~ flip-chip ball array. In a still further variation, the protective shell is in direct contact with the inactive surface of the ~~flip chip. Thereby,~~ flip-chip, the protective shell thereby simultaneously acts as a die attach and heat sink, and the flex substrate with the protective shell provide an enclosure for the grease.

Please amend the third full paragraph appearing on page 5 as follows:

Another embodiment of the present invention includes ~~flip chip on die~~ flip-chip-on-die (FCOD) wherein the ~~flip chip~~ flip-chip is disposed against a COB die. In a first configuration of this embodiment, the ~~flip chip~~ flip-chip ball array is in contact with a grease and the bond wires from the die are enclosed in a second protective material that is typically a thermoplastic or thermoset resin.

Please amend the fourth full paragraph appearing on page 5 as follows:

An alternative embodiment of the FCOD configuration provides for grease to be in contact with both the ~~flip chip~~ flip-chip ball array and the bond wires from the die. A protective shell is disposed upon the substrate supporting the die such that the protective shell and the substrate enclose therein both the ~~flip chip~~ flip-chip and the die.

Please amend the first full paragraph appearing on page 6 as follows:

Another alternative embodiment of the FCOD configuration provides for a two-piece protective shell that may allow the inactive surface of the ~~flip chip~~ flip-chip to be exposed. This alternative embodiment provides for the ~~flip chip~~ flip-chip ball array and the bond wire to be encompassed by grease while allowing the inactive surface to radiate heat away from the ~~flip chip.~~ flip-chip.

Please amend the second full paragraph appearing on page 6 as follows:

These and other features of the present invention will become more fully apparent from the following description and appended ~~claims,~~ claims or may be learned by the practice of the invention as set forth hereinafter.

Please amend the first full paragraph appearing on page 7 as follows:

In order that the manner in which the above-recited and other advantages of the invention are obtained, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are ~~not therefore~~ not, therefore, to be considered to be limiting of its scope, the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

Please amend the sixth full paragraph appearing on page 7 as follows:

Figure 5 is an elevational cross-section view of an alternative embodiment of the chip-on-board configuration depicted in Figure 4 wherein the protective shell acts as a ~~direct-contact~~ direct-contact heat sink to the active surface of the chip;

Please amend the ninth full paragraph appearing on page 7 as follows:

Figure 8 is an elevational cross-section view of an alternative embodiment of a ~~flip-chip-on-flex~~ flip-chip-on-flex configuration according to the present invention;

Please amend the paragraph bridging pages 10 and 11 as follows:

Vent holes 26 may be provided in protective shell 24 in order to allow the expansion of grease 22 under high temperature cycling conditions. Vent hole 26 may be a single vent hole or a plurality of vent holes. Vent hole 26 allows for the expansion of an excess amount of grease 22 during such high temperature applications as burn-in testing. The size of vent hole 26 may be

such so as to allow for excess grease 22 to exude from within the enclosure formed by protective shell 24 and substrate 14. Multiple vent holes can also be employed.

Please amend the third full paragraph appearing on page 11 as follows:

The BOC configuration lends itself well to multiple BOC packages that use grease 22 as a heat transfer medium and as a protective substance. Figure 2 illustrates a multiple BOC chip package 110 wherein substrate 14 has its own IC chip 12 and ball array 20 along with protective shell 24 that contains grease 22. Over first side 50 of substrate 14 is disposed a substrate 114 and an enclosed ball array 132. Substrate 114 supports an IC chip 112 to comprise a second BOC configuration that is stacked upon substrate 14. Figure 2 also illustrates a third BOC configuration such that three BOC configurations comprise chip package 110.

Please amend the paragraph bridging pages 11 and 12 as follows:

A second protective shell 34 encloses the major portion of chip package 110. Disposed in the interstices of chip package 110 is grease 22. Alternatively, a dam structure 128 may also be provided upon first side 50 of substrate 14 and against second protective shell 34 in order to hold second protective shell 34 against substrate 14. Although not pictured, one or multiple vent holes ~~or may~~ may be provided as illustrated in Figure 1. The vent holes may be provided both for protective shell 24 and for protective shell 34.

Please amend the first full paragraph appearing on page 12 as follows:

Another alternative embodiment of multiple, stacked BOC configurations is illustrated in Figure 3 as a chip package 210. The configuration of each BOC substructure is vertically inverted in comparison to the configuration of each BOC substructure depicted in Figure 2. The embodiment depicted in Figure 3 includes substrate 14 and IC chip 12 disposed upon first side 50 of substrate 14. In this embodiment, ball array 20 is also disposed upon first side 50. Figure 3 depicts that each active surface 16~~, two~~ and 216 of IC chips ~~216,~~ 12 and 212, and all bond wires 18 and 218, as well as substrates 214 and connective elements 232, are enclosed in a single space

formed principally by protective shell 224 and substrate 14. Thereby, two protective shells are not required and chip package 210 is enclosed substantially in a common space with all active surfaces and electrical connectors being in contact with grease 22 contained therein. A vent hole (not pictured) may also be present.

Please amend the second full paragraph appearing on page 13 as follows:

Figure 5 illustrates an alternative to the embodiment of chip package ~~210~~ 310 depicted in Figure 4. A chip package 410 illustrated in Figure 5 depicts a section of a protective shell 424 that makes contact with upper surface 16 of IC chip 312. In this configuration, direct contact of protective shell 424 with upper surface 16 comprises a die-attach heat sink. Where the thermal conductivity of protective shell 424 is greater than the thermal conductivity of grease ~~22,~~ 22 and where direct contact by protective shell 424 is made onto IC chip 312, heat transfer away from IC chip 312 is facilitated to a greater degree than the embodiment depicted in Figure 4. It is noted that protective shell 424 can also be attached to chip 312 at active surface 16 through a conductive adhesive or an epoxy such as those used for the-attach applications and are known in the art.

Please amend the paragraph bridging pages 13 and 14 as follows:

Figure 6 is another embodiment of the present invention, wherein a chip package 510 is depicted that includes an IC chip 512 disposed against a heat sink 30. A substrate 514 bearing ball array 520 is disposed upon heat sink 30 and active surface 16 is in electrical connection with a first side 550 of substrate 514 through bond wires 518. According to the present invention, grease 22 is in contact with active surface 16 of IC chip 512 and with bond wires 518. Further, grease 22 is enclosed by a protective shell 524 that also is disposed upon substrate 514. According to this embodiment of the present invention, chip package 510 allows for a significant amount of heat transfer into heat sink 30, while also allowing a significant amount of heat transfer from active surface 16 and bond wires 518 into grease 22. As in all other embodiments

set forth in the present invention, a vent hole is optional. Further, a dam structure is also optional.

Please amend the first full paragraph appearing on page 14 as follows:

Figure 7 illustrates another embodiment of the present invention wherein a chip package 610 comprises flip-chip-on-flex (FCOF) technology. A ~~flip chip~~ flip-chip 612 has a ball array 620 disposed upon active surface 16 thereof. Ball array 620 is disposed upon a substrate 614 that is typically a flexible PCB. Non-flexible substrates can also be employed. Grease 22 is disposed both against active surface 16 and in contact with each individual ball of ball array 620. Typically, dam structure 28 is an epoxy material or glob top material. Grease 22 ~~is therefore~~ is, therefore, containerized by the combination of active surface 16 of ~~flip chip~~ flip-chip 612, dam structure 28 that acts as a container, and the first surface 650 of substrate 614. As is typical with FCOF, a second ball array 36 is disposed upon the second side 648 of substrate 614. It is notable that Figure 7 discloses no vent hole to allow for the expansion and contraction of grease 22. A vent hole, however, may be formed by placing a hole in substrate 614 at a location that opens up to first side 650 without any obstruction from an electrical connection disposed upon first side 650.

Please amend the second full paragraph appearing on page 14 as follows:

Figure 8 is another embodiment of FCOF technology according to the present invention. An FCOF package 710 is depicted as comprising ~~flip chip~~ flip-chip 612 with ball array 620 disposed upon active surface 16 thereof. In place of dam structure 28 to act as the container, a protective shell 624 is displayed as being disposed upon substrate 614. Protective shell 624 is used for enclosing grease 22 along with a combination of protective shell 624, and first side 650 of substrate 614. Grease 22 thus substantially contacts all exposed surfaces of ~~flip chip~~ flip-chip 612 and also contacts all exposed electrical connectors that comprise ball array 620.

Please amend the paragraph bridging pages 14 and 15 as follows:

A particular advantage of the embodiment depicted in Figure 8 is that it allows for a shared heat load by all portions of ~~flip chip~~ flip-chip 612 through the medium of grease 22 as a heat transfer material. Where one portion of ~~flip chip~~ flip-chip 612 may be more microelectronically active than any other portion, grease 22 will heat in that region and allow for heat to be drawn away therefrom to other portions of ~~flip chip~~ flip-chip 612 that are not as active.

Please amend the first full paragraph appearing on page 15 as follows:

Another embodiment of the FCOF configuration is depicted in Figure 9, wherein a chip package 810 includes ~~flip chip~~ flip-chip 612 and ball array 620 disposed upon substrate 614 at its first side 650. Additionally, a protective shell 824 is disposed upon substrate 614 but it also makes direct contact with ~~flip chip~~ flip-chip 612 at its inactive surface 52. Thus, protective shell 824 acts as a die-attach for ~~flip chip~~ flip-chip 612. Simultaneously, protective shell 824 is both a heat sink and a container for holding grease 22 against active surface 16 of ~~flip chip~~ flip-chip 612 and against the electrical connectors that make up ball array 620.

Please amend the second full paragraph appearing on page 15 as follows:

Another application of the present invention is directed toward ~~flip chip on die~~ flip-chip-on-die (FCOD) technology as depicted in Figure 10. An FCOD package 910 includes an IC chip 912 that acts as the die in the FCOD configuration. IC chip 912, referred to hereafter as die 912, is disposed upon a substrate 914 and also has bond wires 318 that make electrical connection between active surface 16 and first side 950 of substrate 914. A ball array 920 acts as the electrical connector between a ~~flip chip~~ flip-chip 40 and die 912. Grease 22 is depicted as filling the interstices between individual balls of ball array 920, between ~~flip chip~~ flip-chip 40 and die 912. Figure 10 also illustrates the presence of a second protective material 38 that is preferably a thermoplastic or thermoset resin. Second protective material 38 acts as both a container that is disposed upon substrate 914 and as a protective cover for bond wires 318.

Please amend the paragraph bridging pages 15 and 16 as follows:

Figure 11 is another embodiment of an FCOD configuration, wherein a chip package 1010 includes die 912 with a ball array 920 disposed upon active surface 16 of die 912. A ~~flip chip~~ flip-chip 40 is disposed upon ball array 920. A protective shell 924 is disposed upon substrate 914. Contained within protective shell 924 and substrate 914 is grease 22. Figure 11 illustrates direct contact of protective shell 924 against ~~flip chip~~ flip-chip 40. Accordingly, protective shell 924 acts as a conductive heat sink for ~~flip chip~~ flip-chip 40. Where die 912 produces a major portion of heat during ordinary use of chip package 1010, ~~flip chip~~ flip-chip 40 itself acts as a heat sink for die 912 in addition to protective shell 924 as protective shell 924 makes direct contact with ~~flip chip~~ flip-chip 40. Grease 22 operates to moderate extreme temperature fluctuation due to its ability to conduct heat more efficiently than the thermoplastic and thermoset materials of the prior art.

Please amend the first full paragraph appearing on page 16 as follows:

Another embodiment of FCOD technology is depicted in Figure 12, wherein a chip package 1110 is configured with both die 912 and ~~flip chip~~ flip-chip 40 disposed with ball array 920 therebetween. A protective shell 1124 is depicted as being disposed upon substrate 914. Optionally, dam structure 28 assists in securing protective shell 1124 to substrate 914. A second dam structure 44 is also optionally present in order to assist in securing protective shell 1124 to ~~flip chip~~ flip-chip 40. In the embodiment depicted in Figure 12, heat conduction that may occur principally in die 912 is dissipated by the presence of ~~flip chip~~ flip-chip 40 as a heat sink therefor.